Fuel level sensors

Strela

Users manual

10.09.2011

Sapsan Control Co Ltd

www.skontrol.ru

Russia, Chelyabinsk

2011

Content

Brief description 3
Technical data 4
The short description of sensor product range 5
Delivery set 7
Installation of fuel level sensor 7
Calibration of tank 10
Sensor Strela performance test 11
Service and application note 14
Transportation and storage 15
Manufacturer's warranty 15
Appendix 1. Dimensions 16

Brief description

Fuel level sensors STRELA are used for petroleum, oil and lubricants. They enjoy wide application in automotive telematic systems for fuel level recording such as Intellitrac, GoSafe, Enfora, Teltonika. Various interfaces provide a suitable solution for all telematic systems.

FLS Strela is a capacitive fuel level sensor without movable parts. Two aluminum tubes create a capacitor plate; its capacity depends from level inside tubes. FLS Strela is not intended for measuring water: with water inside tubes the output signal coincides with that of a full tank.

There are different kinds of output signal. You can choose among:

- Analog output (0.5-4.5 V, 0.5-3V,0.5-10V,0.5-12V) – Strela A
- Frequency output (500-1500 Hz) – Strela F
- Digital output (serial RS232 of 485 interface with 1024 or 4096 points resolution) – Strela D232, Strela D485
- Custom interfaces by demand: current 4-20 mA, MODBUS, CAN

Electronic components of sensor are immersed into elastic compound that provides maximum protection (IP66) and safety under any operation conditions.

Measuring tubes are made of the material that doesn't react with fuel components.

Sensors are adjustable for desired tank height – you may cut them according to the height of your tank. But from fuel lever sensors (FLS for short) Strela A and Strela F you may not cut more than 50% of initial length.

There is a list of available initial length of sensors: 180, 250, 350, 400, 500, 600, 700, 1000, 1400, 2000 mm. You should choose from this list the most suitable length for your need; however take the longer one to provide the most accurate length.

Strela D232 and Strela D485 can be cut for any height.

Sensors have built-in supply voltage stabilizer and sensor output doesn't depend from onboard voltage.

Sensors have built-in algorhythm of data filtration and averaging that allows us to receive smooth fuel data. You can change averaging settings in Strela D232 and Strela D485 sensors. Data averaging in Strela A and Strela F must be defined while making an order before production.

Sensors have self-diagnostic capabilities.

There are some series of the sensors. For sensors with label PM a body of sensor is electrically not connected with ground.

Technical data

Table 1

Sensor model	Strela A1	StrelaA3	Strela D232, Strela D485	Strela F	Strela PP
-type of output signal	Analog, voltage	Analog, resistive(Ohm)	Serial interface RS232 or RS 485 Data protocol: Omnicomm, Modbus	Frequency, Hz	Pulse-packet, pulses, per minute
Fuel level 0%	2.5	800 Ohm, 350 Ohm, 90 Ohm	-	500 Hz	500 Pulses/min
Fuel level 100%	5,7,10*		-	1500 Hz	1500 Pulses/min
Fuel alarm output	-	0,5 Ohm	-	-	-
Supply voltage, V	10...30				
Maximum current, mA	100	100	50	100	100
Distance from lower end from tank after installation, mm	1... 20				
Length of sensor,mm	180...2000 and up to 10000 for composite sensors				
Measurement error, % of sensor length	± 0.1	± 0.3	± 0.1... ± 0.025 and less	± 0.1	± 0.1
Max value of error**	± 1,0 %.				
Self-diagnostic feature	+	-	+	+	+
An allowed cutting value, %	30	30	50	30	30

* On vehicles with 12V onboard circuit voltage can sometimes drop below 10V. In this case sensor will not able to form a signal being that of a full tank – signal will be limited by onboard voltage. We recommend for 12V vehicles to use sensors with 0.5-7V output.
** Error caused by external temperature in range – 40^0C + 55^0C

Table 2

Working temperature,°C	-40 +65
Average time before malfunction T_{av}*	12500 hours
Protection class	IP66
Power consumption, W	< 0.2
Dimensions, mm	L x 70 x 70
Mass, kg	0.3...3
Operation time	Not limited

The short description of sensor product range

FLS Strela A is a widely used fuel level sensor with analog voltage output.

Advantages:

1) Voltage output range is extended up to 12 V - it is a MUST for AVL trackers with analog input of 0-24V (Teltonika, and 90% others)

2) No signal pulses above 1-3 mV

3) Self-diagnostic codes

4) Output circuit protection

5) Isolation of sensor body from "ground" power supply - you can connect fuel level sensor directly to car battery.

Note: The voltage drop below 10 V is possible on the vehicles with 12 V board electric mains. In that case the sensor is not able to produce signal equal to that of full tank level. The signal will be limited by supply voltage. We recommend to order sensors with maximal output signal up to 7V for vehicle with 12 V board electric mains.

FLS Strela A3 should be used in combination with standard fuel level indicators.
Sensor Strela A3 can:

- Determinate fuel level and produce signal equal to the quantity of fuel in the tank.
- Produce signal of minimal balance of the fuel.

The sensor may be used in combination with standard fuel level indicators. Equivalent of sensor resistance corresponds to the range 800 Ohm, 350 Ohm, 90 Ohm.

As a part of GPS-monitoring system sensor has one fail - the voltage across analog input depends not only on sensor output, but also on standard indicator resistance and board electric mains voltage.

Strela F

The fuel level sensors Strela F have greater accuracy and indication stability in comparison with Strela A. The tank fuel level is coded by frequency that linearly varies by changing of fuel level. The signal format is meander 50%, pulse height is equal to half of supply voltage. Currently such terminals as GOSAFE support these sensors.

Main advantages:

ü High resistance to external pickups, poor ground and other interfering signals due to great pulse height

ü No loss of data quality on terminal analog to digital converter in compartment with analog output

The disadvantage of FLS with pulse output:

- As a rule there is a lack of terminal software support

Strela PP

The fuel level sensors Strela PP have same advantages over Strela A as Strela F. The output signal extends with pulse packet. Packet communication frequency is 1 minute for work mode and 15 seconds for test mode. Pulse count in work mode codes measurable value (from 500 to 1500 pulses). Pulse count in test mode codes error type. Pulse count in packet is over 380 Hz. The signal format is meander 50%; pulse height is equal to the half of supply voltage.

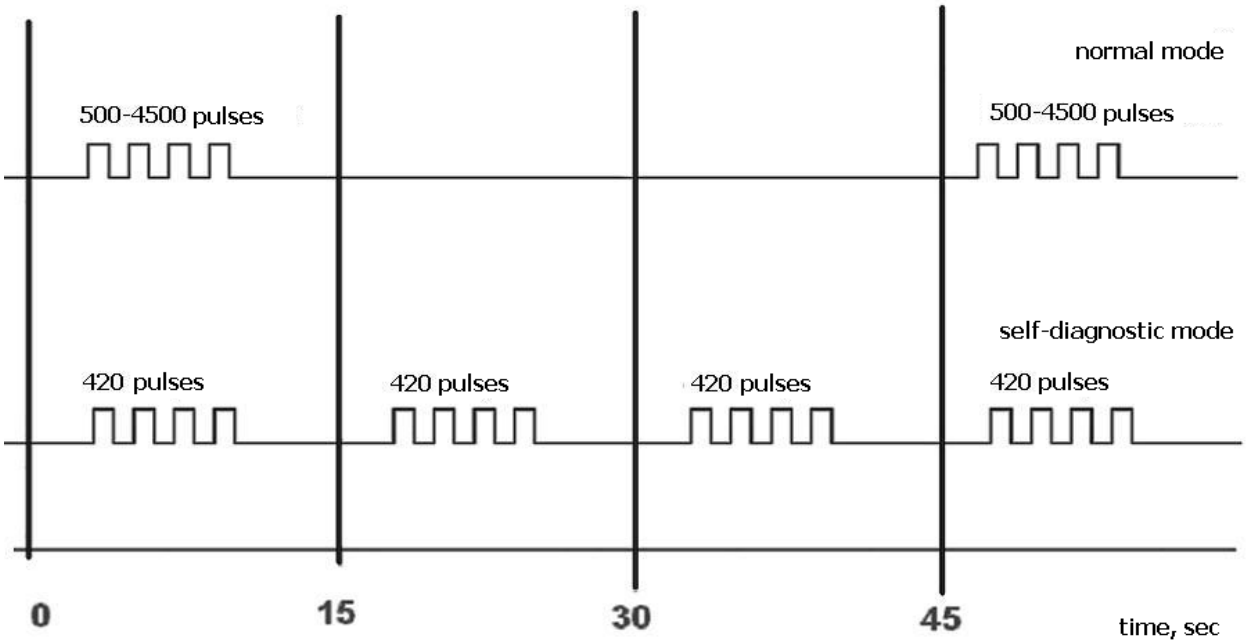

Fig. 1.**. Format of output signal of FLS Strela PP**

FLS Strela D232 (D485)

The fuel level sensors Strela D 232 (D485) with digital interface RS232 (RS48) are used with record or monitoring systems that have input interface. There are some compatible AVL devices – Intellitrac, Teltonika, DaisyTrack.
Digital interface can work with MODBUS protocols or with Omnicomm–compatible protocol. Protocol parameters: 19200 bit per second, 8 bit, 1 stop bit. Resolution - up to 63535 points per length.

Main advantages:

- **ü** High resistance to external pickups, poor ground and other interfering signals due to great pulse height
- **ü** No loss of data quality on terminal analog to digital converter in compartment with analog output

Delivery set

In the set there are sensor, 4-m cable, gasket, screws, passport

Fig. 2 delivery set

Installation of fuel level sensor

It is recommended to install FLS Strela in the center of tank, in addition to vehicle level sensor.

In some cases (when vehicles are used on rugged terrain and tank shape is symmetric) the installation of TWO FLS is recommended.

Sometimes FLS Strela can be installed instead of truck level sensor. But in this case you should take into account that:

1. For better measurement the best place for FLS installation is geometric center of the tank (see Fig. 3). Truck level sensor is usually mounted not in the center.
2. FLS Strela have no output on vehicle fuel indicator, you will need FLS gauge unit to connect it to gauge.

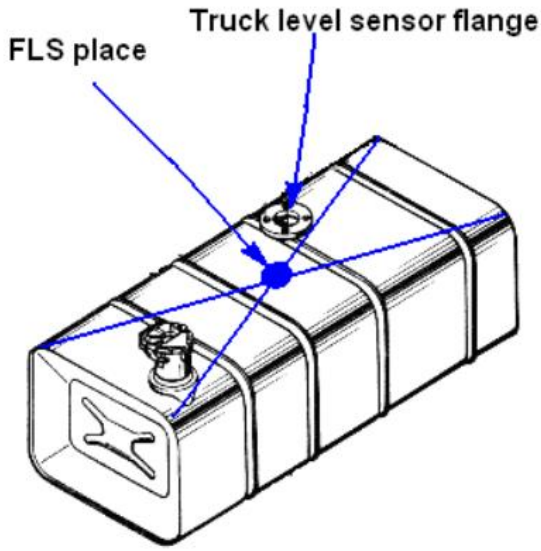

Fig. 3**. Recommended installation scheme**

Sequence of installation:

1) Drill holes for FLS flange (see fig. 4). Usually bi-metall drill head with 35mm diameter is used.

Fig. 4. Bi-metall bore HAWERA

Before drilling a hole in a tank with diesel fuel you should refuel it until full. In this case explosive vapor will not produced. If you drill a hole in tank with petrol fuel you should load it with water instead of petrol fuel!

It is better to start from central hole, after that insert sensor in hole and mark places for outside 5 holes. They are not symmetric! We use standart hole SAE-5 PIN – see dimensions in Appendix 1).

2) Cut a FLS for desired length with saw – see fig. 5. You should leave about 5-10 mm for water on a bottom of the tank. For Strela A, Strela F: Length of sensor after cutting should be not less than 30 and 50% of initial length accordingly! If your tank needs a shorter sensor – you need Strela with shorter initial length!

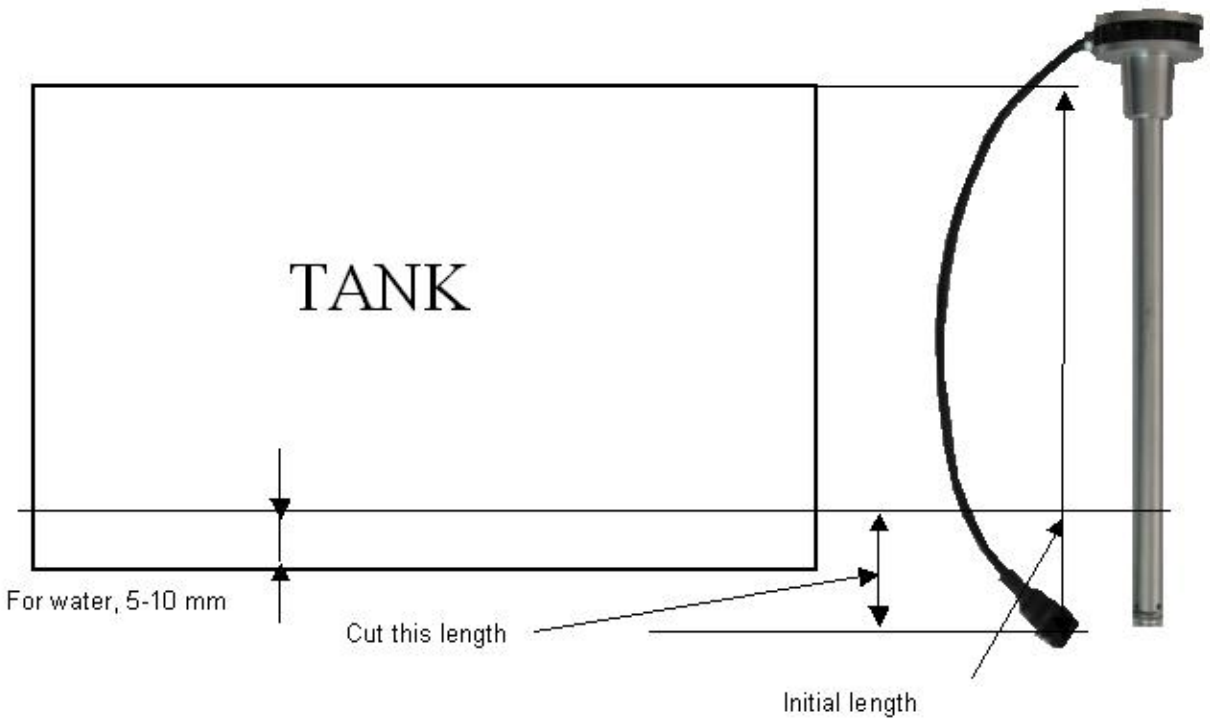

Fig. 5 Cutting a sensor

3) For Strela D232 or D485 –**make a sensor calibration** (see instruction of Calibration).

4) According to wiring diagram from passport connect supply voltage, ground and output signal to telematic system. Be aware of incorrect connection – FLS may be burned out!

Please follow sensor connection circuit into vehicle electrical system!

Don't mix up cables. Wrong connection may bring sensor out of operation.
Don't apply supply voltage over +30V!

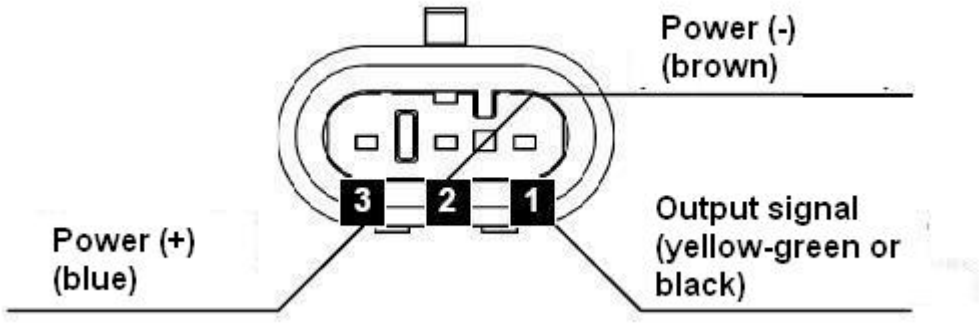

Fig. 6 Strela A, Strela F, Strela PP connector and wiring

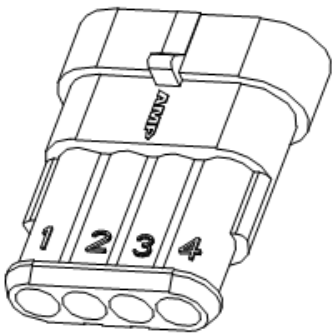

Fig. 7 Strela D232. Strela D485 connector and wiring

Table. 1

	Strela D232	Strela D485	Colour	
1	"-"	"-"	brown	
2	"+"	"+"	blue	
3	Rx	RS-A	Yellow-green	
4	Tx	RS-B	Black	

Calibration of tank

Table 3- an example of tank calibration table

Liters	Sensor output value, Hz
20	300
70	370
130	460
180	530
230	600
280	665
330	730
380	795
440	870

The tank calibration consists in recording in the ROM of terminal or AVL software the conversion table of sensor output signal (voltage, frequency, pulses and others) to fuel volume value.

Tank calibration technique:

1) Stop vehicle on the flat part of the road (road angularity must minimized).
2) Discharge tank completely.
3) Add fuel till sensor will begin to change indication. Write into table added fuel value.
4) Add in tank by 10-50 liters (lowest value by min and max tank volume, greatest value by half empty tank). Get new proper values of sensor output signal and write down them into the table.

Sensor Strela performance test

Resistance between pipes works out about 500 kOhm. If value is a sequence less you should check whether there is a contamination between pipes.

Strela A1. Without fuel immersion voltage on the working sensor at the output in reference to ground must range from 0.1 to 2.5 V (depending on cutting). Full tank output voltage may be 8 - 10 V (depending on cutting). When sensor touches water diagnostic code is 1.4 V. It is possible to produce versions with decreased output voltage (under order).

Table 4. Errors diagnostic codes

No	Code, V	Error description
1	1,0	Sensor is not calibrated at lowest and upper point
2	1,2	Sensor is not calibrated at upper point
3	1,4	Oscillator frequency is equal to 0 (pipe closing against each other particularly because of water)
4	1,6	Divide by zero, sensor was calibrated at the same point
5	1,8	Reading error EEPROM
6	2,0	Break through upper range F> (Fmax+10%) (possible reason is change of fuel type or significant water rate in the fuel)
7	2,2	Break through lowest range F < (Fmin – 10%)
8	2,4	Calibrating contact point is short-out

Strela F. Without fuel immersion signal frequency on working sensor at the output in reference to ground must range from 600 to 700 Hz (depending on cutting). Full tank frequency may be equal to 1300 – 1600 Hz (depending on cutting). When sensor touches water the diagnostic code is 340 Hz.

Table 5. Errors diagnostic code

No	Code, sensor output signal, Hz	Error description
1	300	Sensor is not calibrated at lowest and upper point
2	320	Sensor is not calibrated at upper point
3	340	Oscillator frequency equal to 0 (pipe closing against each other particularly because of water)
4	360	Divide by zero, sensor was calibrated at the same point
5	380	Reading error EEPROM
6	400	Break through upper range F> (Fmax+10%) (possible reason is change of fuel type or significant water rate in the fuel)
7	420	Break through lowest range F < (Fmin – 10%)
8	440	Calibrating contact point is short-out

Strela PP. Without fuel immersion pulse packet on working sensor at the output in reference to ground must be 600 – 750 pulses (depending on cutting). Full tank pulse packet must be equal to 4300 – 4600 pulses (depending on cutting). When sensor touches water the diagnostic code is 340 pulses packet. Packet communication frequency is one minute for work mode and 15 seconds for test mode (see fig.1)

Table 6. Errors diagnostic code

No	Code, sensor output signal, pulse count	Error description
1	300	Sensor is not calibrated at lowest and upper point
2	320	Sensor is not calibrated at upper point
3	340	Oscillator frequency equal to 0 (pipe closing against each other particularly because of water)
4	360	Divide by zero, sensor was calibrated at the same point
5	380	Reading error EEPROM
6	400	Breakthrough upper range F> (Fmax+10%) (possible reason is change of fuel type or significant water rate in the fuel)
7	420	Breakthrough lowest range F < (Fmin – 10%)
8	440	Calibrating contact point is short-out

Strela D232 and D485. The error codes transfer with protocol (see appendix 2)

Table 7. Errors diagnostic code

No	Code	Error description
3	003	Oscillator frequency equal to 0 (pipe closing against each other particularly because of water)
5	005	Reading error EEPROM
6	006	Breakthrough upper range F> (Fmax+10%) (possible reason is change of fuel type or significant water rate in the fuel)
7	007	Breakthrough lowest range F < (Fmin – 10%)

Table.8 Causes of error appearance

Error	Failure description	Working ability	Repair
Oscillator frequency equal to 0	**Description:** oscillator is stopped – sensor doesn't measure fuel level **Type of failure:** error is of sporadic* (water short-out when vehicle is in motion) or permanent (when mechanical short-circuit occur) nature. After cause is eliminated the sensor passes into work mode. **Cause:** Sensing element pipes are short-out – water in the fuel, mechanical short-circuit.	Works	1. Dry sensor, drain water from the tank; 2. Eliminate mechanical short-circuit. Check resistance between sensing element pipes when sensor is off by circuit analyzer. Resistance value must range from 460 to 500 k Ohm.
Reading error EEPROM	**Description:** set sensor calibration parameters failed. **Type:** error appears at once when you switch sensor on and has permanent nature, i.e. fuel immersion, wire short-circuits doesn't effect on sensor output signal. **Cause:** possible static electricity impact by static electricity while sensor cutting.	doesn't work	Replacement **Check:** close sensing element electrodes by metallic object, if sensor output signal didn't change then sensor is out of work.
Breakthrough at upper range F> (Fmax+10%)	**Description:** sensor stands by zero if fuel level is low than gives an error. **Type:** error occurs on dry sensor. If you submerse sensor into fuel it works properly after it passes dead zone. **Cause:** more then 10% of non-cutting sensor or more than 40% of cutting sensor was cut. The problem may also be caused by damage of sensing element coating.	Dead zone below	Replacement **Check:** Submerse sensor into fuel it works properly after it passes dead zone.

Breakthrough lowest range F < (Fmin – 10%)	**Description:** fuel level is over real value, sensor gives error from time to time. **Type:** error occurs at sensor immersion on the level that is close to maximal one or on any other level by water short-out. If error changes to error «Oscillator frequency equal to 0», then the problem is caused by water in the fuel. **Cause:** measurement fluid is different from diesel fuel or gasoline. Circuit shot of measuring element by water in tank.	Works	**Check:** by submersion of sensor into the fuel the output signal is proportional to sinkage.

*Sporadic – from time to time.

Service and application note

- ü Sensor operation requirements are stated in sensors certificate.
- ü To avoid sensor breakdown do not expose sensors to aggressive environments, electromagnetic fields as well as mechanical and weather loads, that exceed determined parameters in the present guide;
- ü Do not connect sensor to devices which have interface that fails to meet the specification, indicated in present performance specification and detailed engineering drawings;
- ü After sensor installation on vehicle or equipment it is recommended to seal all electrical connections;
- ü Sensors repair must be done by qualified staff that has repair right certificate
- ü An exterior check is essential before introduction sensors into service. If there are mechanical damages (cracks, shears, dents and etc) at sensor than sensors introduction into service is not allowed;
- ü Sensors service must be done by staff that studied the device, its mode of functioning and all instruction indicated in sensor certificate;
- ü It is recommended to use proper grade diesel fuel that answer to range of temperature (summer, winter, arctic) to All-Union standard 305.

Maintenance support

Product does not need maintenance support

Maintenance repair

Product is nonrepairable.

Transportation and storage

Transportation

The sensors transportation must be done in enclosed transport of any type that can provide protection for sensor against mechanic damage and exclude impact of atmospheric fallout onto pack.
By air transport sensors are places in heated pressurized module.
The air in vehicles should not contain acid, alkaline and others aggressive addictive agents.
Transport package with packed sensor must be sealed. Sealing method should exclude access to packed sensor without removal of the seal.

Storage

Storage of sensors in the same facility with metal corrosive materials or materials containing aggressive addictive agents is not allowed.

Manufacturer's warranty

1. Guarantee period is 18 month from manufacture data, which is indicated in product certificate.
2. Manufacturer guarantees product working ability under keeping of service rules, transportation and storage rules by customer.
3. Products that have been installed by experts that have received training in Sapsan Export Trade and have personal certification are covered under warranty.
4. Sensors with damage (cracks and shears, dents, impact marks, chamber choking etc) that occured through customer's fault due to violation of service, storing and transportation terms are not covered under warranty.

Appendix 1. Dimensions